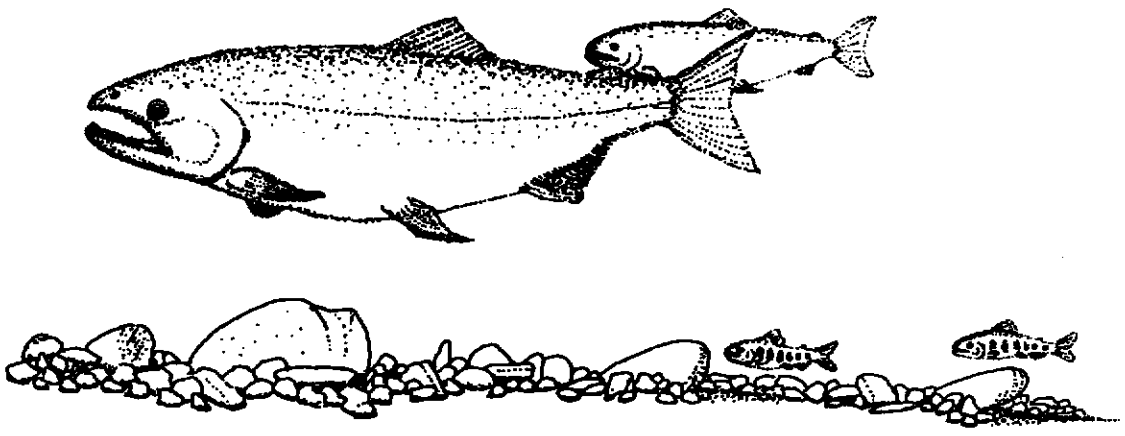
U.S. FISH AND WILDLIFE SERVICE

# MIGRATION OF JUVENILE PINK SALMON (Oncorhynchus gorbuscha) THROUGH DUNGENESS BAY CLALLAM COUNTY, WASHINGTON



WESTERN WASHINGTON FISHERY RESOURCE OFFICE

OLYMPIA, WASHINGTON

NOVEMBER 1994

# MIGRATION
# OF
# JUVENILE PINK SALMON
# (*Oncorhynchus gorbuscha*)
# THROUGH
# DUNGENESS BAY,
# CLALLAM COUNTY, WASHINGTON

Prepared for the

National Park Service
Olympic National Park
Port Angeles, Washington

by

Joseph M. Hiss

U.S. Fish and Wildlife Service
Western Washington Fishery Resource Office
Olympia, Washington

18 November 1994

## ABSTRACT

Juvenile salmonids were collected by beach seine from 12 locations in and around Dungeness Bay, Clallam County, Washington from 1 April to 3 June, 1994. The objective was to describe the timing, migration path, and length frequency of pink salmon (*Oncorhynchus gorbuscha*) and other salmonids during their seaward migration from the Dungeness River to the Strait of Juan de Fuca. This information will help guide efforts to restore Dungeness pink salmon, a stock which is proposed for introduction into the Elwha River basin in furtherance of the Elwha River Ecosystem and Fisheries Restoration Act.

Pink salmon juvenile migration began in the first week of April, peaked in late April, and ended by the third week of May; however, most had cleared the nearshore waters by the end of April. Juvenile pinks first occurred in waters most sheltered from prevailing winds, then moved alongshore into more exposed waters closer to the Strait. Fry ranged from 31 to 74 mm FL, with the majority between 35 and 55 mm.

Juvenile chum migration began before the first week of April and was still continuing at a low level in the first week of June. Timing was distinctly bimodal. Abundance of early migrants peaked during the first week of April, while later migrants peaked around the last week of April. Lengths from the combined groups ranged from 30 to 80 mm FL. Length frequency distribution was also bimodal, with a major group between 35 and 55 mm and a minor group between 55 and 65 mm. Early-migrating chum first appeared in the west end of the bay and, like pinks, appeared to migrate eastward toward the entrance of the bay. Later-migrating fish appeared simultaneously in the Dungeness River and the west end of the bay and also migrated eastward. Most chum fry had become unavailable to beach seining by mid-May.

Wild coho smolt migration began before the first week of April, peaked in mid-May, and was continuing at a low level in the first week of June. Coho entered the intertidal zone when only a few pink fry remained; coho were more likely to encounter chum fry in this area although chum had also largely completed their migration through the nearshore waters of the bay. Length ranged from 35 to 134 mm FL, with most individuals between 85 and 110 mm.

Delay of the 1994 hatchery coho release from the Washington Department of Fish and Wildlife's Dungeness Hatchery until after 1 June appeared sufficient to protect wild pink and chum fry from predation in the nearshore waters of Dungeness Bay. However, previous years' releases of hatchery coho in April could have contributed to the present depressed state of the Dungeness pink salmon runs.

No chinook smolts were encountered at any time during the study, perhaps due to the extremely small escapements of 1992 and 1993.

# INTRODUCTION

The Elwha River Ecosystem and Fisheries Restoration Act (PL 102-495) of 1992 established the goal of full restoration of the Elwha River's ecosystem and native anadromous fisheries (Section 3(d)). Federal, state, and tribal fishery agencies plan to accelerate restoration by releasing hatchery-reared juvenile salmonids into the river upstream of the existing dam sites for 8 to 10 yr after safe fish passage is assured (USDI et al. 1994).

The agencies have identified pink salmon (*Oncorhynchus gorbuscha*) among the candidates for hatchery-assisted restoration (USDI et al. 1994). The native Elwha pinks are considered critically depleted (WDF et al. 1993) and not abundant enough to support a hatchery program. Moreover, their confinement to the lower Elwha for 80 yr by the Elwha Dam suggests that this run may no longer be adapted for restocking the upper Elwha. Therefore, the agencies are considering, as a first priority, transferring fish from the nearby Dungeness River (USDI et al. 1994).

The Dungeness supports a wild native summer-run pink population that tends to migrate to the highest accessible spawning grounds in that basin (WDF et al. 1993), and would be ideally suited for introduction in th Elwha River. However, this run is also depressed, perhaps critically so (WDF et al. 1993; Appendix A of this report). For this reason, the Dungeness summer pink population will have to be restored to health before transfers can be made into the Elwha. Assisting in restoration of Dungeness pink salmon will therefore help achieve the objectives of the Elwha River Ecosystem and Fisheries Restoration Act.

Several factors, including instream flow, spawning gravel quality and stability, and predation may contribute to the depressed condition of Dungeness pink salmon. The only directly manageable aspect of predation is the timing of release of hatchery coho smolts from the WDFW Dungeness Fish Hatchery, located near RKm 16 (RM 10) of the Dungeness River.

Upon entry to the estuary, juvenile chum and pink salmon usually occupy shallow sublittoral habitats before moving into the neritic zone (Simenstad et al. 1982). Predation on these species by coho was documented as early as 1971 (Bonar et al. 1989). Experiments have shown that yearling coho prey selectively on pinks over other salmonid species (Hargreaves and LeBrasseur 1985). Young salmon usually remain in the littoral zone until they reach a size which is less vulnerable to predation, about 55 to 70 mm (Crain 1992).

Historically, hatchery procedures required that coho smolts be released during March or April to make pond space available for fry of the next brood year; these releases occurred well in advance of the timing of normal coho downstream movement, and this placed them in the stream at the time of emergence and downstream migration of pink and chum fry (Johnson 1973). To the degree that coho smolt releases overlapped pink salmon fry migrating out of the Dungeness River or through Dungeness Bay (Figure 1), unnaturally high pink mortality may have followed (Lichatowich 1992). To ensure that coho smolts are released only after pink fry have left the bay, the WDFW

The small net was used exclusively in the early dates; the large net became available in mid-season and gradually replaced the small net at all sites (Table 1). This change was justified since demonstrating pink fry presence or absence late in the migration was more important than precisely estimating catch per effort. The relatively deep, long, fine-meshed net was considered the more likely to demonstrate presence of pink fry if they were present in the nearshore waters.

The small net was set by two persons on foot. The large net was set from an outboard-powered 7-m (22-ft) open boat, while a person on shore held one end of the net in a stationary position. One to ten sets were made per site with the small seine, and one to three with the large seine. Sets per site remained constant over the season, with very few exceptions.

After the net was brought ashore each fish was counted. Salmonids were identified to species, while other fish were identified to genus or family. Up to 20 salmonids of each species were anesthetized with MS-222 and measured for fork length to the nearest millimeter. All fish were then allowed to recover and returned to the water.

Catch data from both seines were pooled for analysis of distribution over time and location. Pink salmon length frequency was analyzed for the effects of site and date. To examine the effect of site, length data from sites having similar peak timing were pooled until at least 20 lengths were obtained. To examine the effect of timing, length data from consecutive weeks were pooled until at least 20 lengths were available.

## RESULTS AND DISCUSSION

### Species Captured

Sculpins (Cottidae) were the most abundant fish family (Table 2); starry flounder *(Platichthys stellatus)* and Pacific sand lance (*Ammodytes hexapterus*) were also very common. Of the salmonids, chum salmon were most abundant, followed by pink and coho. Cutthroat (*O. clarki*) and steelhead trout were rare, and chinook salmon were not captured on any occasion.

### Pink Salmon Fry

*Migration Timing and Distribution*

Migration through the nearshore waters of Dungeness Bay apparently began during the first week of April (Table 3). This is relatively late relative to pink runs in general (Bonar et al. 1989). Beach seine catch peaked during the latter part of that month, as expected in view of the previously reported mid-April peak in downstream migration on the Dungeness (Johnson 1973). Pink salmon last appeared in seine catches on 20 May. This is relatively early compared to Puget Sound beaches, where pinks persisted until late June (Johnson et al. 1966, 1973; Bonar et al. 1989).

This species was found only in saltwater despite our regular seining in the river. This may be due to their tendency to migrate out of freshwater at night (Bonar et al. 1989). Pinks occurred at most saltwater sites but were absent from Deadman's Spit and the Three Crabs site (Figure 1, sites 8 and 9). Pink juveniles were unusually abundant on 25 April at the navigational daymark (Figure 1, Site 5).

Timing and location of weekly peak catch (Table 3) suggest that pinks concentrated at the base of Dungeness Spit (Figure 1, Site 3) shortly after entry into saltwater and moved eastward along the south shore of the bay until the third week of April. From late April to the third week of May

Dungeness Bay chum abundance peaked during the first week of May (Table 4). This is later than Quilcene Bay chum, which peaked in late April (Kane 1994) but coincides with the later of the two peaks in Puget Sound chum movement -- one in early April and other in early to mid-May -- reported by Johnson et al. (1966) and Johnson (1973). Chum appeared in the last seine catch on 3 June, although in greatly reduced numbers compared to the first two weeks of May. Puget Sound chum fry were last found along beaches in late June (Johnson et al. 1966).

Unlike pink fry, chum were found in the Dungeness River as well in saltwater. This may indicate that Dungeness chum reside in the river longer than pinks. Chum occurred at all saltwater beaches except the two beaches east of the Three Crabs site. Largest weekly catches occurred at Schoolhouse Bridge, located at RKm 1.6 (RM 1.0) of the Dungeness River, at Cline Spit, and near the Oyster House.

Timing and location of peak catches were bimodal. Early migrants appeared in the first week of April at the base of Dungeness Spit, and appeared to travel eastward to the Oyster House area by late April. Late migrants were captured from the river from mid-April to mid-May. Their timing roughly coincided with a second peak in fry abundance at the base of Dungeness Spit and at Cline Spit in April and early May. This late group appears to have concentrated near the Oyster House in mid-May. Very few members of either group remained inshore by late May. Catch data by gear type appear in Appendix C.

Lengths ranged from 30 to 80 mm FL. Distribution was bimodal, with a major group between 35 and 55 mm and a minor group whose lengths were concentrated between 55 and 65 mm (Figure 4). Fish from the daymark site on 25 April were larger on the average and made up about half the chum over 55 mm in length. Occurrence of chum over 60 mm in the intertidal zone is unusual; chum normally remain inshore until they reach a length of 50 to 60 mm (Simenstad et al. 1982).

*Stock Origin*

The apparent bimodal migration pattern suggests that at least the late migrants represented native Dungeness fall-run chum salmon. Three alternative interpretations are possible regarding the origin of the early migrants.

(1) Early migrants represented a summer-run chum spawning in the Dungeness River. An early run has been recently identified on the Dungeness, although the 1993 escapement was very low (Ray Johnson, pers. comm.). Under this hypotheses there should have been a few early chum remaining in the river on 1 April, although no chum were captured from the river at that time.

(2) Early fish represented Puget Sound fall-run stock that had entered saltwater several weeks earlier than Dungeness stock and had grown to a larger size than Dungeness river stock.

(3) Early fish represent Discovery Bay summer-run stock. This hypothesis has the advantage of not requiring the assumption that Puget Sound chum emerged earlier or grew faster than Dungeness stock.

site than the smaller seine, except on one occasion at the daymark site on 25 April. Moreover, the absence of juvenile salmon from most sets suggests that fish schooling and migration, rather than gear type or fishing technique, had the greatest influence on numbers caught.

As expected, the larger seine captured pink fry over a larger size range (Figure 3, top panel), but did not fail to catch the smallest sizes captured in the smaller seine. The effect of net type on fish size was undoubtedly confounded with (1) fish growth while residing in the bay, and (2) our inability to use the large seine in the river or at the base of Dungeness Spit, which was the first saltwater residence of many juvenile salmon.

## SUMMARY AND CONCLUSIONS

1. Pink fry apparently cleared the inshore waters of Dungeness Bay by the third week of May. Pink fry use probably began during the first week of April and peaked in late April.

2. Delay of hatchery coho release until after June is probably sufficient to avoid significant predation potential on pink and chum fry in the inshore waters of Dungeness Bay.

3. Release of hatchery coho smolts in April over the history of Dungeness Fish Hatchery operation could have contributed to the present depressed condition of the Dungeness pink stocks.

4. Chum fry began entering the bay before early April and continued at least until the end of the study in early June. Occurrence peaked in the second week of April and again in early May, suggesting that two populations were migrating through the bay.

5. Wild coho smolts occurred from late April to mid-May. Peak abundance was in late May, after most pink and chum fry had left the nearshore area.

## TABLES

Table 1. Use of small and large beach seines by date and site. Sites are defined in "Methods" section of main report. "S" = small seine; "L" = large seine.

| Week | Seine site 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 APR | S | S | -- | -- | -- | S | S | -- | S | -- | -- | -- |
| 6 APR | -- | -- | S | S | -- | S | S | -- | S | -- | -- | -- |
| 14-15 APR | S | S | S | S | -- | S | S | S | S | S | -- | -- |
| 21-22 APR | S | S | S | S | -- | S | S | -- | S | -- | -- | -- |
| 25-26 APR | S | S | S | S | L | S | S | -- | S | -- | -- | -- |
| 2-5 MAY | S | S | S | S | L | SL | S | -- | SL | SL | -- | -- |
| 10-12 MAY | S | S | S | S | L | SL | SL | L | SL | L | -- | -- |
| 19-20 MAY | -- | -- | -- | L | L | SL | S | -- | SL | L | L | -- |
| 23-26 MAY | -- | -- | S | SL | L | L | -- | -- | L | L | -- | -- |
| 2-3 JUN | -- | -- | -- | L | L | L | -- | -- | L | L | L | L |

Table 2. Fish species captured by beach seine on lower Dungeness River and Dungeness Bay, April-June 1994.

| Common name | Scientific name | Number |
|---|---|---|
| Sculpin | Cottidae, primarily *Leptocottus armatus* | 5,037 |
| Starry flounder | *Platichthys stellatus* | 776 |
| Pacific sand lance | *Ammodytes hexapterus* | 741 |
| Chum salmon | *Oncorhynchus keta* | 723 |
| Shiner surfperch | *Cymatogaster aggregata* | 595 |
| Pink salmon | *O. gorbuscha* | 365 |
| Smelt | Osmeridae | 182 |
| Coho salmon | *O. kisutch* | 103 |
| Bay pipefish | *Syngnathus leptorhynchus* | 22 |
| Gunnel | Pholidae | 8 |
| Cutthroat trout | *O. clarki* | 4 |
| Steelhead | *O. mykiss* | 4 |
| Threespine stickleback | *Gasterosteus aculeatus* | 2 |
| Eelpout | Zoarcidae | 2 |
| Herring | *Clupea pallasi* | 2 |
| Poacher | Agonidae | 1 |

Table 5. Beach seine catch of wild coho smolts from Dungeness River and Bay, 1994. Site numbers are explained in Figure 1. Sites are listed in order according to the date of first peak fry abundance. Data are presented by net type in Appendix D.

| Date | Site number | | | | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Fish | Sites | F/S |
| 4/01 | 0 | 0 | 0 | 0 | 0 | -- | -- | -- | -- | -- | -- | -- | 0 | 5 | 0.0 |
| 4/06 | 0 | -- | -- | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- | 0 | 5 | 0.0 |
| 4/14-15 | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 | -- | -- | 0 | 9 | 0.0 |
| 4/21-22 | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- | 0 | 7 | 0.0 |
| 4/25-26 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -- | -- | -- | -- | 16 | 8 | 2.0 |
| 5/02-05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -- | 0 | -- | -- | 0 | 9 | 0.0 |
| 5/10-12 | 61 | 1 | 15 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | -- | -- | 81 | 10 | 8.1 |
| 5/19-20 | 0 | -- | -- | 0 | 1 | 1 | 1 | -- | -- | 0 | 0 | -- | 3 | 7 | 0.4 |
| 5/23-26 | -- | -- | -- | 0 | 1 | 1 | 0 | 1 | -- | 0 | -- | -- | 3 | 6 | 0.5 |
| 6/02-03 | -- | -- | -- | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 | 0 | 8 | 0.0 |
| Total fish | 77 | 1 | 15 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 103 | | |
| Total wk | 8 | 6 | 6 | 10 | 10 | 6 | 9 | 7 | 3 | 6 | 2 | 1 | | | |
| Fish/wk | 9.6 | 0.2 | 2.5 | 0.4 | 0.2 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

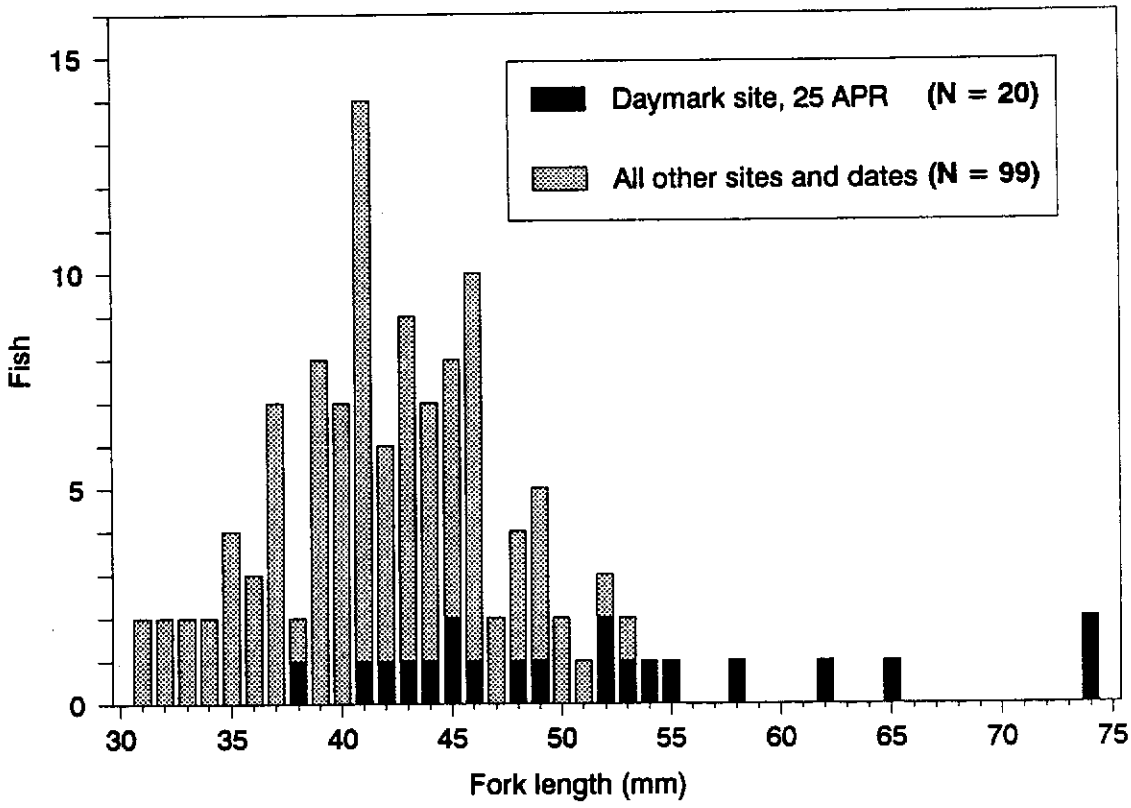



Figure 2. Length frequency of pink salmon fry from Dungeness Bay, April-June 1994.

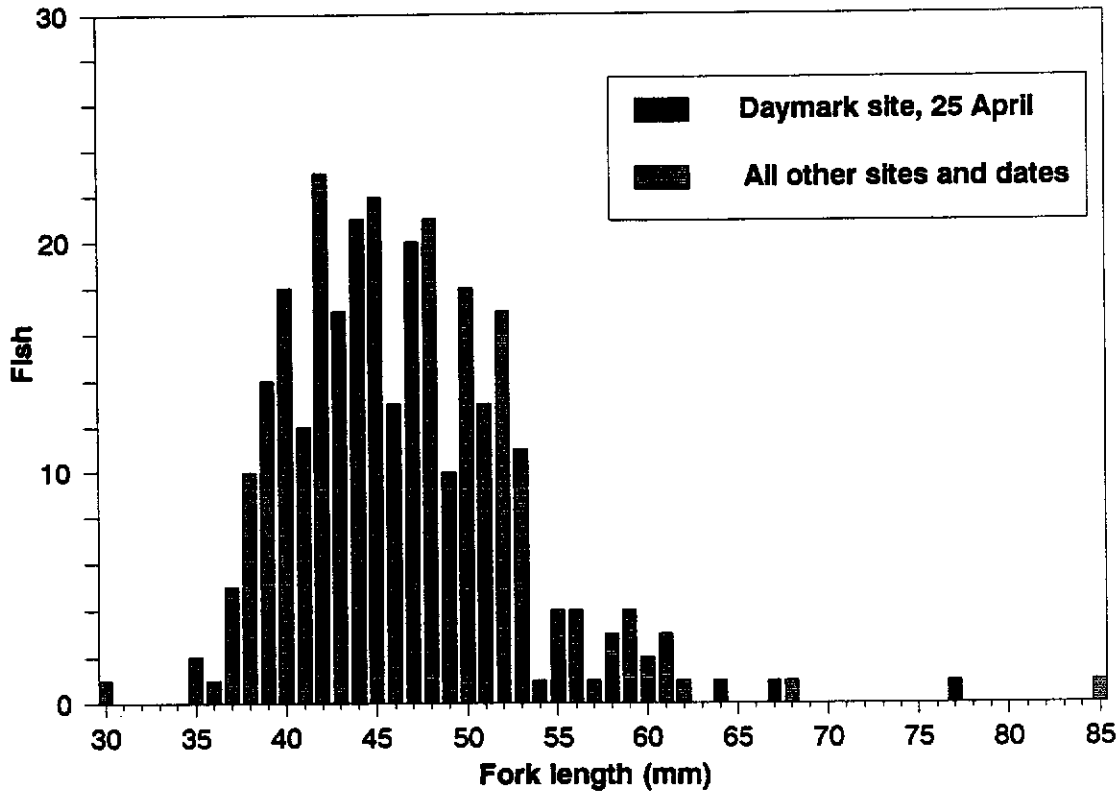



Figure 4. Length frequency of chum salmon fry from Dungeness Bay and lower 1.6 km (1 mi) of Dungeness River, April-June 1994.

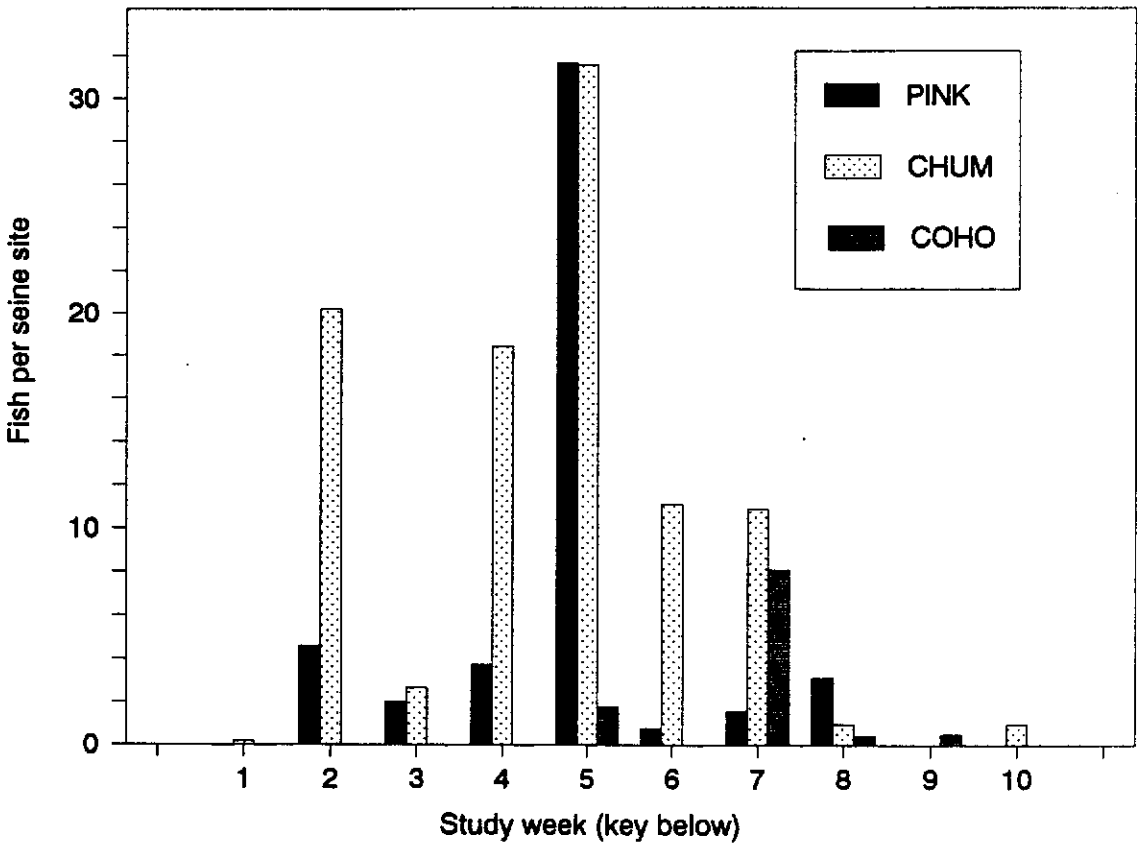



Figure 6. Migration timing overlap among wild coho smolts, pink salmon fry, and chum salmon fry in Dungeness Bay and lower mile of Dungeness River, April-June 1994. Key to study week numbers in figure:

| WEEK | DATES |
|---|---|
| 1 | 1 APR |
| 2 | 6 APR |
| 3 | 14-15 APR |
| 4 | 21-22 APR |
| 5 | 25-26 APR |
| 6 | 2-5 MAY |
| 7 | 10-12 MAY |
| 8 | 19-20 MAY |
| 9 | 23-26 MAY |
| 10 | 2-3 JUN |

Appendix B. Pink salmon fry catch data.

| 9.1 m (30 ft) seine | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3 | 4 | 6 | 7 | 9 | 5 | 10 | 1 | 2 | 8 | 11 | 12 |
| 1 APR | – | – | 0 | 0 | 0 | – | – | 0 | 0 | – | – | – |
| 6 APR | 23 | 0 | 0 | 0 | 0 | – | – | – | – | – | – | – |
| 14-15 APR | 0 | 16 | 2 | 0 | 0 | – | 0 | 0 | 0 | 0 | – | – |
| 21-22 APR | 0 | 3 | 9 | 13 | 1 | – | – | 0 | 0 | – | – | – |
| 25-26 APR | 0 | 0 | 0 | 6 | 0 | – | – | 0 | 0 | – | – | – |
| 2-5 MAY | 0 | 0 | 0 | 0 | 0 | – | 0 | 0 | 0 | – | – | – |
| 10-12 MAY | 0 | 0 | 0 | 0 | 0 | – | – | 0 | 0 | – | – | – |
| 19-20 MAY | – | – | 0 | 0 | 0 | – | – | – | – | – | – | – |
| 23-26 MAY | 0 | 0 | – | – | – | – | – | – | – | – | – | – |
| 2-3 JUN | – | – | – | – | – | – | – | – | – | – | – | – |

| 29 m (95 ft) seine | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3 | 4 | 6 | 7 | 9 | 5 | 10 | 1 | 2 | 8 | 11 | 12 |
| 1 APR | – | – | – | – | – | – | – | – | – | – | – | – |
| 6 APR | – | – | – | – | – | – | – | – | – | – | – | – |
| 14-15 APR | – | – | – | – | – | – | – | – | – | – | – | – |
| 21-22 APR | – | – | – | – | – | – | – | – | – | – | – | – |
| 25-26 APR | – | – | – | – | – | 247 | – | – | – | – | – | – |
| 2-5 MAY | – | 0 | 7 | – | 0 | 0 | – | – | – | – | – | – |
| 10-12 MAY | – | – | 0 | 0 | 0 | 0 | 16 | – | – | 0 | – | – |
| 19-20 MAY | – | 1 | 0 | – | 0 | 0 | 21 | – | – | – | 0 | – |
| 23-26 MAY | – | 0 | 0 | – | 0 | 0 | 0 | – | – | – | – | – |
| 2-3 JUN | – | 0 | 0 | – | 0 | 0 | 0 | – | – | 0 | 0 | 0 |

| Nets combined | Site | | | | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3 | 4 | 6 | 7 | 9 | 5 | 10 | 1 | 2 | 8 | 11 | 12 | Fish | Sites | F/S |
| 1 APR | – | – | 0 | 0 | 0 | – | – | 0 | 0 | – | – | – | 0 | 5 | 0.0 |
| 6 APR | 23 | 0 | 0 | 0 | 0 | – | – | – | – | – | – | – | 23 | 5 | 4.6 |
| 14-15 APR | 0 | 16 | 2 | 0 | 0 | – | 0 | 0 | 0 | 0 | – | – | 18 | 9 | 2.0 |
| 21-22 APR | 0 | 3 | 9 | 13 | 1 | – | – | 0 | 0 | – | – | – | 26 | 7 | 3.7 |
| 25-26 APR | 0 | 0 | 0 | 6 | 0 | 247 | – | 0 | 0 | – | – | – | 253 | 8 | 31.6 |
| 2-5 MAY | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | – | – | – | 7 | 9 | 0.8 |
| 10-12 MAY | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | – | – | 16 | 10 | 1.6 |
| 19-20 MAY | – | 1 | 0 | 0 | 0 | 0 | 21 | – | – | – | 0 | – | 22 | 7 | 3.1 |
| 23-26 MAY | 0 | 0 | 0 | – | 0 | 0 | 0 | – | – | – | – | – | 0 | 6 | 0.0 |
| 2-3 JUN | – | 0 | 0 | – | 0 | 0 | 0 | – | – | 0 | 0 | 0 | 0 | 8 | 0.0 |
| Total fish | 23 | 20 | 18 | 19 | 1 | 247 | 37 | 0 | 0 | 0 | 0 | 0 | 365 | | |
| Weeks samp. | 7 | 9 | 10 | 8 | 10 | 6 | 6 | 6 | 6 | 3 | 2 | 1 | | | |
| Fish/wk | 3.2 | 2.2 | 1.8 | 2.3 | 0.1 | 41. | 6.1 | 0 | 0 | 0 | 0 | 0 | | | |

Appendix D. Wild coho smolt catch data.

| 9.1 m (30 ft) seine | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3 | 4 | 7 | 5 | 9 | 1 | 2 | 6 | 8 | 10 | 11 | 12 |
| 4/01 | 0 | 0 | 0 | 0 | 0 | -- | -- | -- | -- | -- | -- | -- |
| 4/06 | 0 | -- | -- | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- |
| 4/14-15 | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 | -- | -- |
| 4/21-22 | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- |
| 4/25-26 | 16 | 0 | 0 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- |
| 5/02-05 | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- |
| 5/10-12 | 53 | 1 | 15 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- |
| 5/19-20 | 0 | -- | -- | 0 | 0 | -- | -- | -- | -- | -- | -- | -- |
| 5/23-26 | -- | -- | -- | -- | -- | -- | 0 | 1 | -- | -- | -- | -- |
| 6/02-03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

| 29 m (95 ft) seine | Site | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 7 | 5 | 9 | 1 | 2 | 6 | 8 | 10 | 11 | 12 |
| 4/01 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/06 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/14-15 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/21-22 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/25-26 | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- |
| 5/02-05 | -- | -- | -- | 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- |
| 5/10-12 | 8 | -- | -- | 4 | 0 | 0 | -- | -- | 0 | 0 | -- | -- |
| 5/19-20 | -- | -- | -- | 0 | 1 | 1 | 1 | -- | -- | 0 | 0 | -- |
| 5/23-26 | -- | -- | -- | 0 | 1 | 1 | 0 | -- | -- | 0 | -- | -- |
| 6/02-03 | -- | -- | -- | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 |

| Nets combined | Site | | | | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 3 | 4 | 6 | 7 | 9 | 5 | 10 | 1 | 2 | 8 | 11 | 12 | Fish | Sites | F/S |
| 4/01 | | 0 | 0 | 0 | 0 | 0 | -- | -- | -- | -- | -- | -- | -- | 0 | 5 | 0.0 |
| 4/06 | | 0 | -- | -- | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- | 0 | 5 | 0.0 |
| 4/14-15 | | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 | -- | -- | 0 | 9 | 0.0 |
| 4/21-22 | | 0 | 0 | 0 | 0 | 0 | -- | 0 | 0 | -- | -- | -- | -- | 0 | 7 | 0.0 |
| 4/25-26 | | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -- | -- | -- | -- | 16 | 8 | 2.0 |
| 5/02-05 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -- | 0 | -- | -- | 0 | 9 | 0.0 |
| 5/10-12 | | 61 | 1 | 15 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | -- | -- | 81 | 10 | 8.1 |
| 5/19-20 | | 0 | -- | -- | 0 | 1 | 1 | 1 | -- | -- | 0 | 0 | -- | 3 | 7 | 0.4 |
| 5/23-26 | | -- | -- | -- | 0 | 1 | 1 | 0 | 1 | -- | 0 | -- | -- | 3 | 6 | 0.5 |
| 6/02-03 | | -- | -- | -- | 0 | 0 | 0 | 0 | -- | 0 | 0 | 0 | 0 | 0 | 8 | 0.0 |
| Total fish | | 77 | 1 | 15 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 103 | | |
| Weeks samp | | 8 | 6 | 6 | 10 | 10 | 6 | 9 | 7 | 3 | 6 | 2 | 1 | | | |
| Fish/wk | | 9.6 | 0.2 | 2.5 | 0.4 | 0.2 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | | | |

## FIGURES

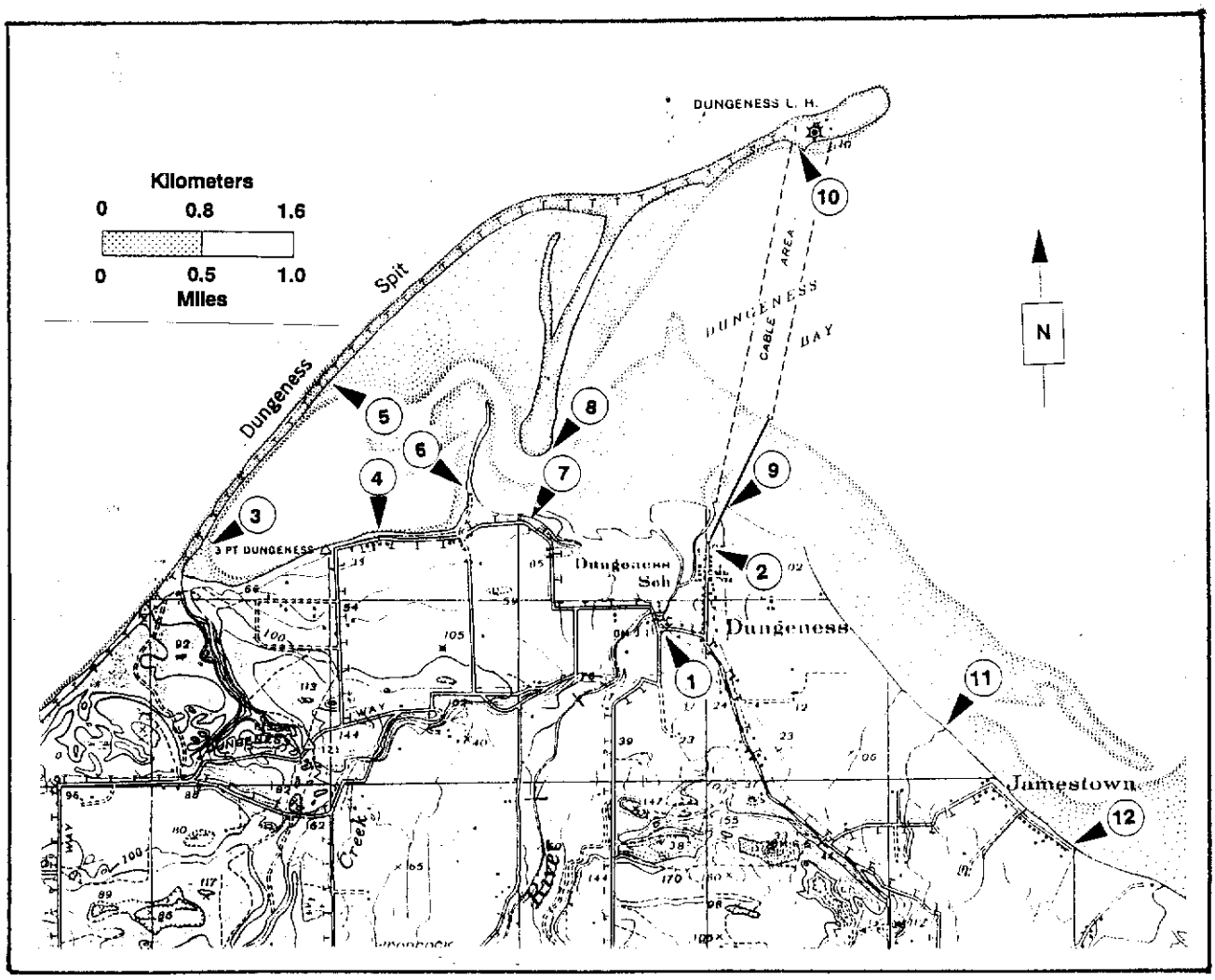



Figure 1. Dungeness Bay and lower Dungeness River, showing 1994 beach seine sites. Sites are identified by landmarks as follows:

Site 1 -- Dungeness river at Schoolhouse Bridge (RKm 1.6 (RM 1.0)).
Site 2 -- Dungeness River at Sports Club (RKm 0.8 (RM 0.5))
Site 3 -- Base of Dungeness Spit
Site 4 -- Near boat ramp at Dungeness Bay Motel
Site 5 -- Near navigational daymark on Dungeness Spit
Site 6 -- Public beach on Cline Spit
Site 7 -- Public beach east of Dungeness Oyster House
Site 8 -- Southern tip of Deadman's Spit
Site 9 -- Near Three Crabs Restaurant
Site 10 -- Near Dungeness Lighthouse
Site 11 -- Near mouth of Cassalery Creek
Site 12 -- Near foot of Wilcox Road

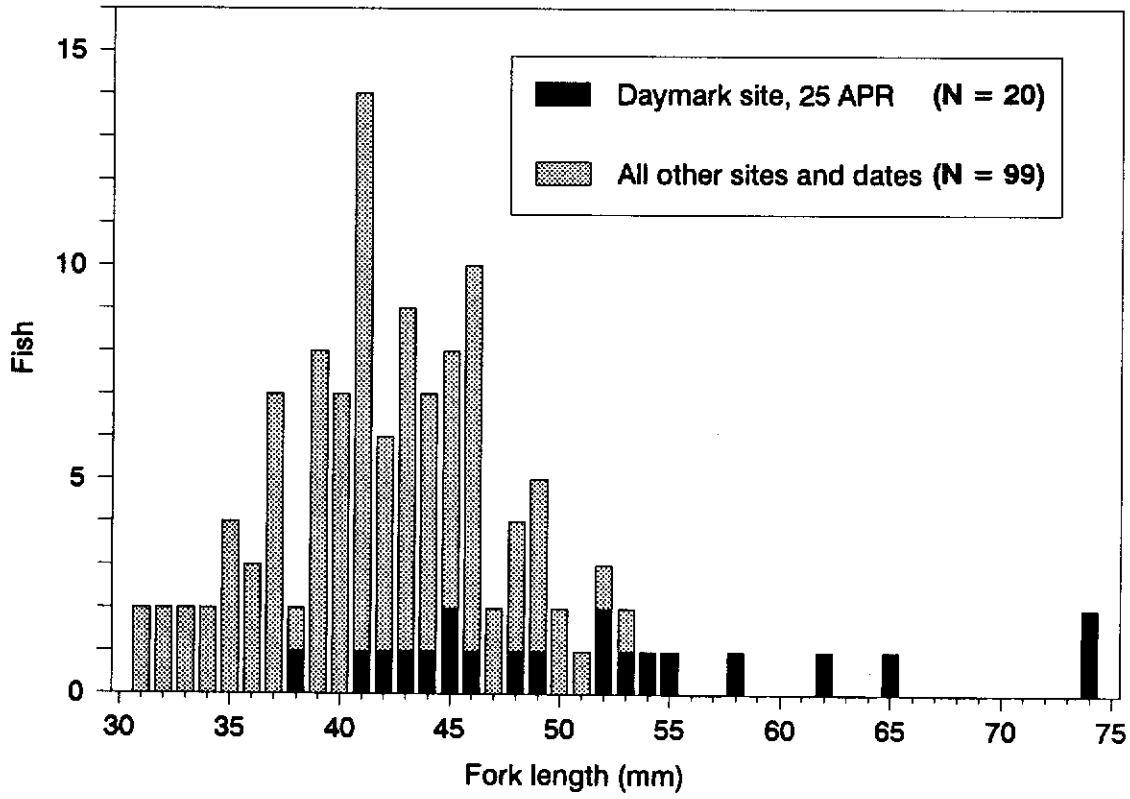



Figure 2. Length frequency of pink salmon fry from Dungeness Bay, April-June 1994.

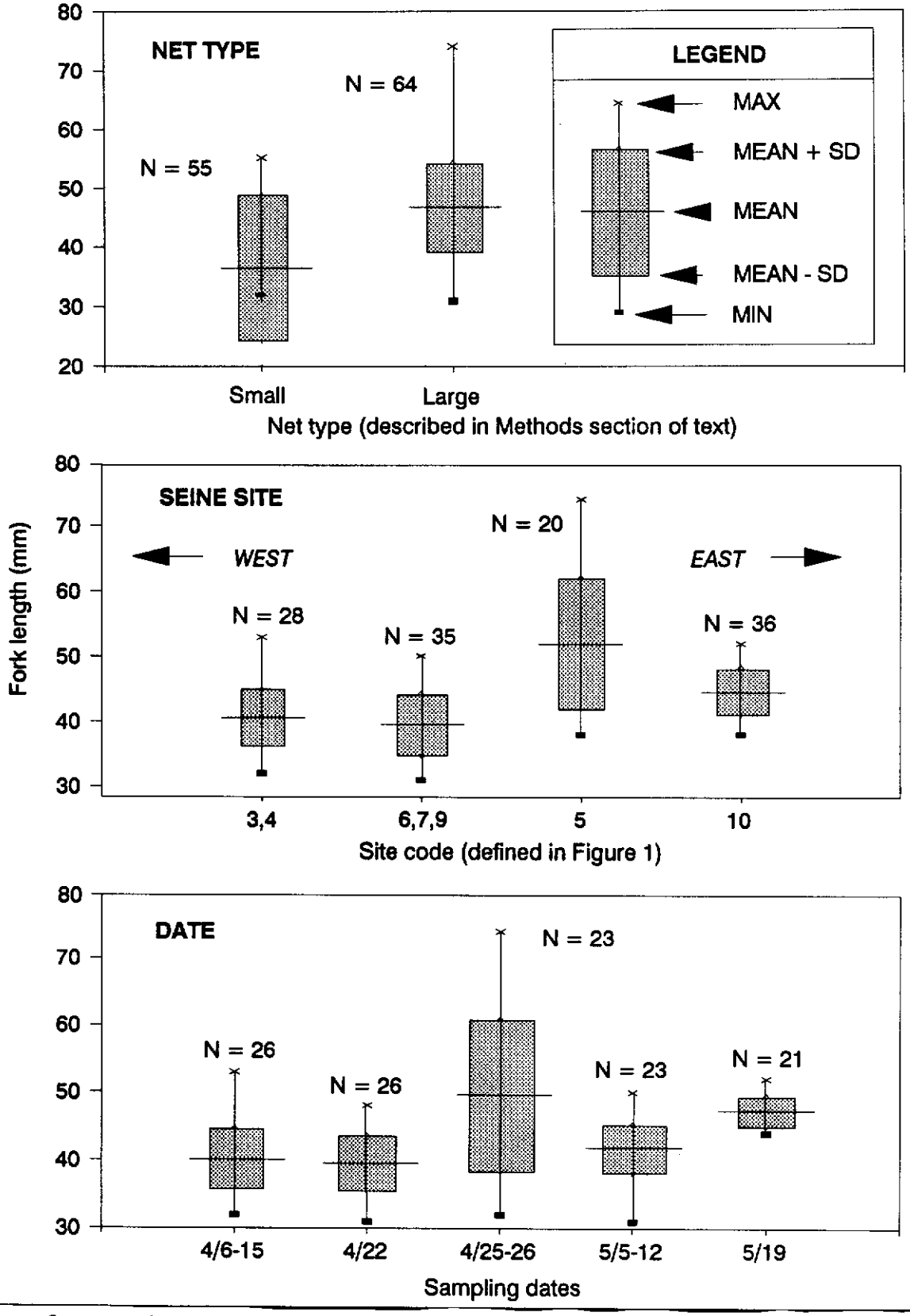



Figure 3. Length frequency of pink salmon fry from Dungeness Bay by gear type, seine site, and date.

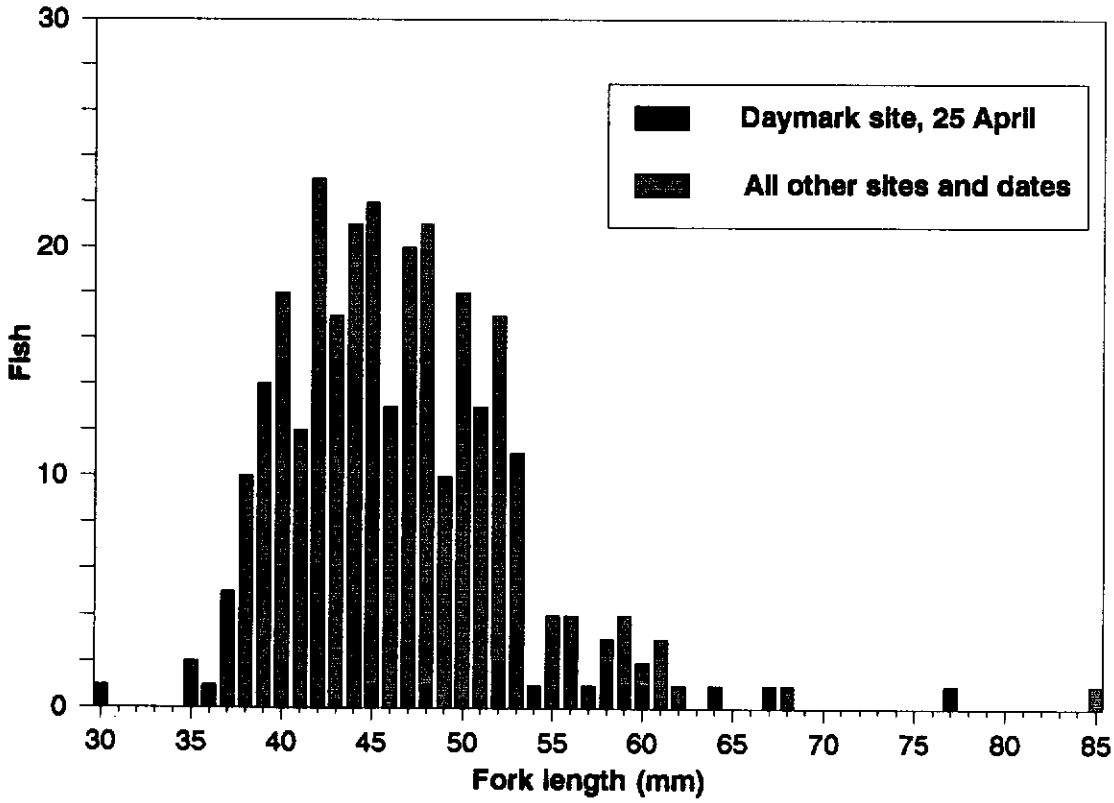



Figure 4. Length frequency of chum salmon fry from Dungeness Bay and lower 1.6 km (1 mi) of Dungeness River, April-June 1994.

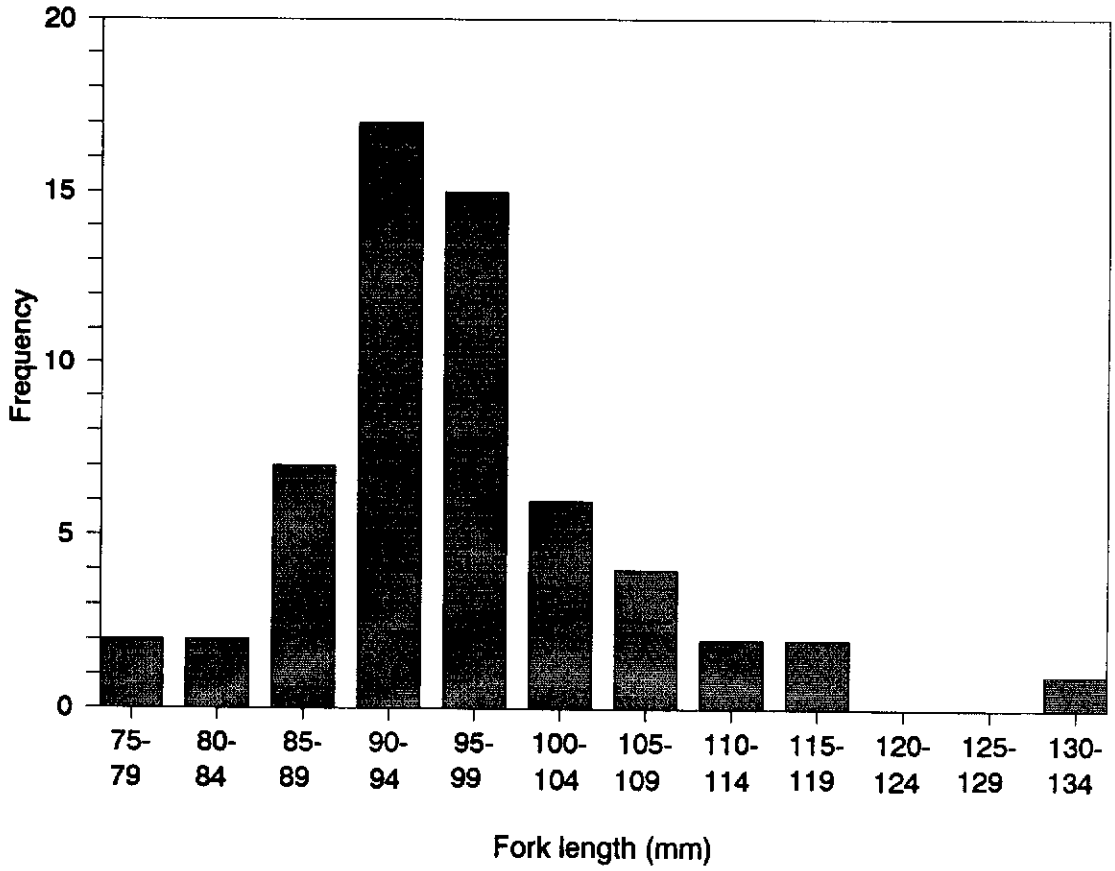



Figure 5. Length frequency of wild coho salmon smolts from Dungeness River and Bay, April-June 1994.

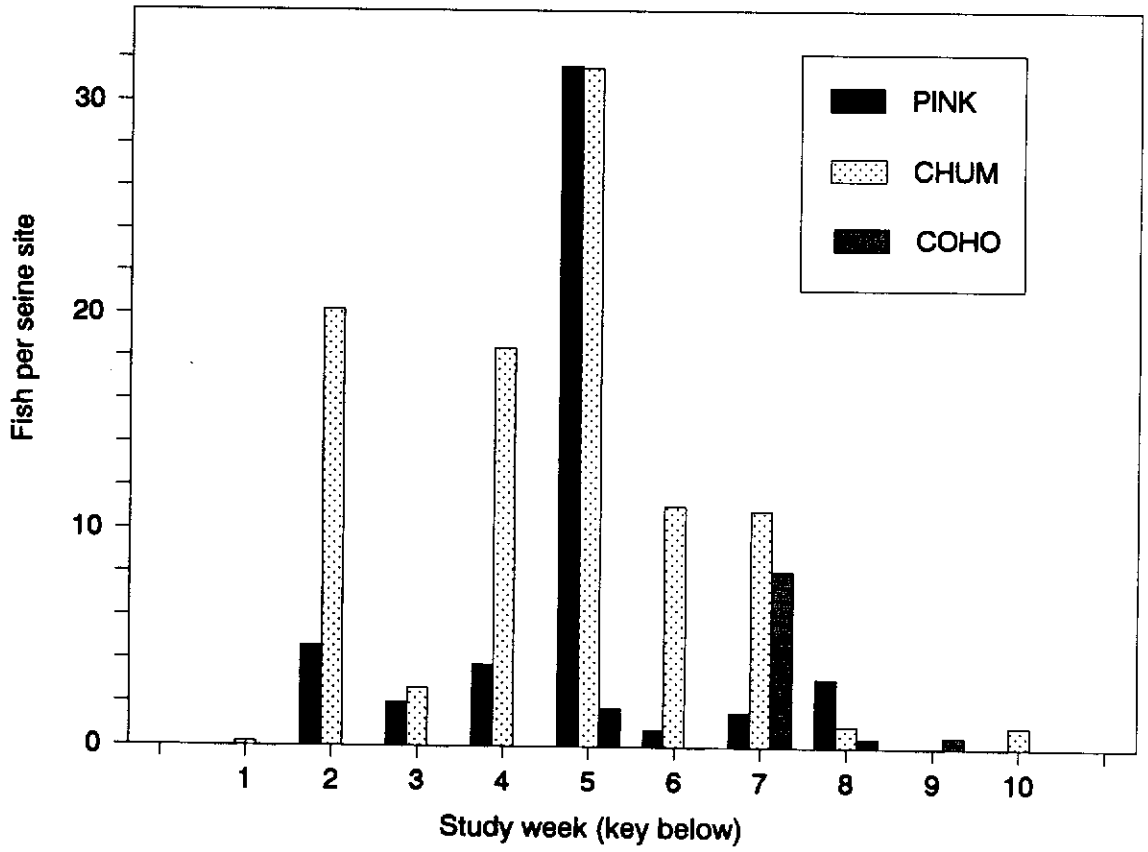



Figure 6. Migration timing overlap among wild coho smolts, pink salmon fry, and chum salmon fry in Dungeness Bay and lower mile of Dungeness River, April-June 1994. Key to study week numbers in figure:

| WEEK | DATES |
|---|---|
| 1 | 1 APR |
| 2 | 6 APR |
| 3 | 14-15 APR |
| 4 | 21-22 APR |
| 5 | 25-26 APR |
| 6 | 2-5 MAY |
| 7 | 10-12 MAY |
| 8 | 19-20 MAY |
| 9 | 23-26 MAY |
| 10 | 2-3 JUN |